Memoirs of the Indian Meteorological Department

VOL. XX, PART 7.

KITE FLIGHTS IN INDIA AND OVER THE NEIGHBOURING SEA AREAS DURING 1907.

BY

J. H. FIELD, M.A.,

IMPERIAL METEOROLOGIST,

Published by order of His Excellency the Viceroy and Governor General of India in Council

UNDER THE DIRECTION OF

GILBERT T. WALKER, M.A., Sc.D., F.R.S.,

DIRECTOR GENERAL OF OBSERVATORIES.

SIMLA:

GOVERNMENT CENTRAL BRANCH PRESS.

1908.

Price One Rupee.

PUBLICATIONS OF THE INDIA METEOROLOGICAL DEPARTMENT.

[illegible] following is a list of the more important publications [illegible]

[illegible] I, 2nd Edition. Price Rs. 3 — Henry [illegible] ford.

Indian Meteorologist's *Vade Mecum*, Part II (1877) Price Rs. 5* — Ditto.

[illegible]uctions to Observers [illegible] nent, 2nd Edition. ([illegible] — [Jo]hn Eliot.

[illegible]es for the reduction [illegible] India, 2nd Edition. ([illegible] — [H.] F. Blanford.

[illegible] of Bengal for the use [illegible] (1900). Price Rs. 4 — Sir John Eliot.

[illegible] of Bengal for the use [illegible] s. (1901) Price Re. 1-8 — Ditto.

[illegible] [Cycl]one of May [illegible] Price Re. 1* — Ditto.

[illegible] Cyclone of August [illegible] Price Rs. 3 — Ditto.

[illegible] Price Rs. 3 — Ditto.

[illegible] Memoirs, Part IV—An enquiry into the nature and [illegible] Arabian Sea and a catalogue and [illegible] storms in the Arabian Sea [illegible] Price Rs. 3 — W. L. Dallas.

[illegible] Memoirs, Part V—Account of three Cyclones in the Bay of Bengal and Arabian Sea during November, 1891. (1893) [illegible] Price Rs. 3 — Sir John Eliot.

[Rep]ort of the Midnapore and Burdwan Cyclone of the 15th and 16th of October, 1874. (1875) Price Rs. 3* — W. G. Wilson.

[Rep]ort of the Vizagapatam and Backergunge Cyclones of October, 1876. (1877) Price Rs. 3* — Sir John Eliot.

[Rep]ort on the Madras Cyclone of May, 1877. (1879) Price Rs. 3* — Ditto.

[Mon]thly weather charts of the Bay of Bengal and adjacent sea north of the equator, showing mean pressure, winds and currents. (1886) Price Rs. 5 — Henry F. Blanford.

[Mon]thly weather charts of the Arabian Sea and the adjacent portion of the North Indian Ocean, showing mean pressure, winds and currents. (1888) Price Rs. 5 — Sir John Eliot.

[Cha]rts of the Bay of Bengal and adjacent sea north of the equator, showing the specific gravity, temperature and currents of the sea surface. (1887) Price Re. 1-8 — W. L. Dallas.

[Clim]atological Atlas of India (1906). Price Rs. 27 or 36 shillings — Sir John Eliot.

[Dai]ly weather reports and charts of the Indian monsoon area for the years 1893 to 1899 Price, each month, Re. 1* — Departmental.

[Nor]mal weather or pilot charts of the Indian monsoon area for 8 A.M. for each mont[h] [illegible] 1903† [illegible] 4 — Ditto.

[Rai]nfall data of India for the [illegible] 5* — Ditto.

[Re]ports on the Meteorology of India for the years 1875—1890 (16 volumes)‡ Price each Rs. 10 — Ditto.

[Ind]ia Weather Review—Annual Summaries for the years 1891—1906 (16 parts)¶ Price each Rs. 3 — Ditto.

[Mo]nthly Weather Reviews for each month, January, 1891, to August, 1907§ Price, each part, Re. 1 — Ditto.

[Ind]ian Meteorological Memoirs, Vol. I, containing:—

[Par]t I, comprising—
[On] the winds of Calcutta—An analysis of ten years' hourly observations of the wind vane and four years' anemograms.
[Th]e meteorology and climate of Yarkhand and Kashgar, being chiefly a discussion of registers kept by Dr. J. Scully in 1874-75
[Th]e diurnal variation of the barometer at Simla. Price Rs. 3* — Henry F. Blanford.

[Pa]rt II, comprising—
[Sto]rms in Bengal during the year 1876, accompanied with increased atmospheric pressure and the apparent reversal of the normal diurnal oscillation of the barometer — Sir John Eliot.
[On] the rainfall of Benares considered in relation to the prevailing winds — S. A. Hill.

On the diurnal var[iation] [illegible] Part I, Calcu[tta] [illegible] Price Rs. 3* — Henry F. Blanford.

Part III, comprising—
[illegible] observations in Western [illegible] with a discussion [illegible] Price Rs. 3 — S. A. Hill. / Henry F. Blanford.

Part IV [illegible] Price Rs. 3 — Fred. Chambers.

Part V [illegible] — S. A. Hill. / Henry F. Blanford.

Part VI, comprising—
The Meteorology of the North-West Himalaya Price Re. 1 — S. A. Hill.

Indian Meteorological Memoirs, Vol. II, containing:—
[illegible] 18th to the 24th [illegible] Bay of Bengal [illegible] India and in the [illegible] Price Rs. 2 — Sir John Eliot. / Fred. Chambers.

Part II, comprising—
Note on the foregoing list of cyclones and on the Gujarat [is]land cyclone of July 11th to 13th, 1881 — Henry F. Blanford.
On the temperature of North-Western India Price Rs. 2 — S. A. Hill.

Part III, comprising—
Account of the south-west monsoon storms of the 8th to the 19th October, 1882, in the Bay of Bengal Price Rs. 2 — Sir John Eliot.

Part IV, comprising—
Account of south- [illegible] the Bay of Bengal duri[ng] [illegible] Price Rs. 2 — Ditto.

Part V, comprising [illegible]

Indian Meteorological Memoirs, Vol. [illegible] discussion of the rainfall of India, complete in 4 parts [illegible] — [H.] F. Blanford.

Indian Meteorological Memoirs, Vol. IV, containing:—
[illegible] monsoon storm of the 12th to the [illegible] Bay of Bengal and at Akyab — Sir John Eliot.
On the diurnal variation of the rainfall at Calcutta — Henry F. Blanford.
The meteorological features of the southern part of the Bay of Bengal Price Rs. 3* — W. L. Dallas.

Part II, comprising—
The False Point cyclone of September 22nd, 1885. Price Rs. 2* — Sir Alexander Pedler.

Part III, comprising—
On [illegible] made at the old ob- [illegible] Price Re. 1-8* — S. A. Hill.

[illegible] [sou]th-west monsoon storms during the years 1882 to [illegible] Price Rs. 3 — Sir John Eliot.

Part V, comprising—
The cyclonic storms of November and December, 1886, in the Bay of Bengal — Ditto.
[illegible] to the 2nd June, 1881, in the [illegible] Price Rs. 3 — Fred. Chambers.
[illegible] made at Allahabad [illegible] Price Re. 1-8 — S. A. Hill.

Part VII, comprising—
The Arabian Sea cyclone of the 4th to the 13th June, 1887 — Fred. Chambers.
On the Meteorology and Climatology of Northern Afghanistan Price Re. 1-8* — W. L. Dallas.
[illegible] [co]ld weather storms in [illegible] Price Rs. 3* — Sir John Eliot.

---

* Copies of publications to the price of which an asterisk is appended are out of print.

† The [illegible] [mons]oon area for 8 A.M. is a monthly publication. Copies for Jan[uary] [illegible] and September, 1901, [illegible] [Jan]uary to O[ctober] [illegible] out of print.

‡ Copi[es] [illegible] the years 1876, 1878 to 1881, 1884, 1887 and 1890 are out of print.

¶ Copies of the India Weather Reviews—Annual Summary for the years 1891 to 1904, are out of print.

§ The Monthly Weather Review is a monthly publication continuously published about four months after the month. Copies of Monthly Weather [Re]view for 1891—97, January, 1898, 1899, 1900, 1901, January to May, 1902, January to November (June excepted), 1903, and January 1904, are out of print.

Continued on page iii of this cover.

Kite flights in India and over the neighbouring sea areas during 1907.
By J. H. Field, M. A., Imperial Meteorologist.

1. In July and August 1907 work with kites was resumed at Belgaum in the Bombay Presidency, and in late August and September some attempts were made to obtain records in the Bay of Bengal and Arabian Sea during the course of a passage to England on the B.I.S.S. "Dilwara." The apparatus used was the same as in August 1906 with the exceptions that kites and meteorographs of the Dines pattern were almost exclusively employed, and that at sea the wire winder was the hand machine of which a description has already appeared[1].

2. The work on land, at Belgaum, lasted from July 11th to August 3rd, but it was only during the first week of that period that successful flights were made. Weather had been nearly dry and winds light in the Peninsula for some time previous to July 11th, but from that day onwards the winds increased in velocity until on the 19th the monsoon had become re-established. It was found that, with this change in the weather, eddies of air had formed, similar to those which had been encountered in 1906 beyond the immediate site of the kite shed, and that they were now very pronounced and of great extent: as a consequence of these eddies it proved to be impossible after the 18th to launch kites even on a long line, without great risk of their immediate destruction[2]. In addition to the difficulty of launching, trouble arose from the fact that the winds, as they freshened, became exceedingly squally, so that after the 17th on all occasions when a successful start had been made, the kites were overtaken and broken up by rain squalls within a very short time.

Squally conditions, but of a less pronounced type, had been encountered during the kite work of 1906, and a description of the attendant difficulties was given in the published account of that work[3]. The recurrence of the trouble made it appear important to secure measurements of the variation of wind velocity near the ground during the passage of a rain squall, in order to ascertain whether the maximum velocities were so great that it would be useless to expect that kites of the usual pattern could be made sufficiently strong to be serviceable in an active monsoon.

For this purpose a Robinson anemometer was put up near the kite station, and observations were made at times of the passage of the rain squalls in its neighbourhood. The readings showed that winds which averaged about 11 m. p. s. during the day, and appeared favourable for the purposes of kite flying, would vary in velocity in the course of five or ten minutes from 8 m. p. s. as a rain squall was approaching, up to as much as 20 m. p. s. as its centre actually passed in the neighbourhood of the instrument. These measurements were made at a height of 1·5 m. above the ground, and it seems probable, therefore, that at a height of 100 m. or more the velocity of winds which had been found so destructive to kites may have reached 30 m. p. s. or more for short periods of a few minutes at times of their maximum effect. It would probably be very difficult

---

[1] Indian Meteorological Memoirs, Vol. XX, Part I.

[2] It became evident in the course of the work that the site of the kite shed was unsuitable, and arrangements have accordingly been made for removing it to a new position for work in 1908.

[3] Indian Meteorological Memoirs, Vol. XX, Part 2.

PUBLICATIONS OF THE INDIA METEOROLOGICAL DEPARTMENT.

The following is a list of the more important publications of the India Meteorological Department:—

The Indian Meteorologist's Vade Mecum, Part I, 2nd Edition. (1923) Price Rs. 3	Henry F. Blanford.
The Indian Meteorologist's Vade Mecum, Part II. (1877) Price Rs. 3*	Ditto.
Instructions to Observers of the India Meteorological Department, 2nd Edition. (1902) Price Rs. 3	Sir John Eliot.
Tables for the reduction of Meteorological Observations in India, 2nd Edition. (1895) Price Rs. 2	Henry F. Blanford.
[illegible]	Sir John Eliot.
[illegible]	Ditto.
[illegible]	Ditto.
[illegible]	Ditto.
[illegible]	Ditto.
Cyclone Memoirs, Part IV—An enquiry into the nature and course of storms in the Arabian Sea and a catalogue and brief history of all recorded storms in the Arabian Sea from 1648—1889. (1891) Price Rs. 3	W. L. Dallas.
Cyclone Memoirs, Part V—Account of three Cyclones in the Bay of Bengal and Arabian Sea during November, 1891. (1893) Price Rs. 3	Sir John Eliot.
Report of the Midnapore and Burdwan Cyclone of the 15th and 16th of October, 1874. (1875) Price Rs. 2*	W. G. Willson.
Report of the Vizagapatam and Backergunge Cyclones of October, 1876. (1877) Price Rs. 3*	Sir John Eliot.
Report on the Madras Cyclone of May, 1877. (1879) Price Rs. 5*	Ditto.
Monthly weather charts of the Bay of Bengal and adjacent sea north of the equator, showing mean pressure, winds and currents. (1886) Price Rs. 5	Henry F. Blanford.
Monthly weather charts of the Arabian Sea and the adjacent portion of the North Indian Ocean, showing mean pressure, winds and currents. (1888) Price Rs. 5	Sir John Eliot.
Charts of the Bay of Bengal and adjacent sea north of the [illegible], temperature and [illegible] Price Rs. 1-8	W. L. Dallas.
Climatological Atlas of India (1906). Price Rs. 27 or 36 shillings	Sir John Eliot.
Daily weather reports and charts of the Indian monsoon area for the years 1893 to 1899 Price, each month, Re. 2*	Departmental.
Normal weather or pilot charts of the Indian monsoon area for 8 a.m. for each month, November 1900, to August 1907† Price, each month, Annas 4	Ditto.
Rainfall data of India for the years 1891—1906 (16 volumes). Price for each year, Rs. 5*	Ditto.
Reports on the Meteorology of India for the years 1875—1890 (16 volumes)‡ Price each Rs. 10	Ditto.
India Weather Review—Annual Summaries for the years 1891—1906 (16 parts)¶ Price each Rs. 3	Ditto.
Monthly Weather Reviews for each month, January, 1891, to August, 1907§ Price, each part, Re. 1	Ditto.
Indian Meteorological Memoirs, Vol. I, containing :—	
Part I, comprising—	
On the winds of Calcutta—An analysis of ten years' hourly observations of the wind vane and four years' anemograms. The [illegible] of Yarkand and Kashgar, [illegible] of registers kept by Dr. J. Scully in [illegible]. The [illegible] variation of the barometer at Simla. Price Rs. 3*	Henry F. Blanford.
Part II, comprising—	
Storms in Bengal during the year 1876, connected with increased atmospheric pressure and the apparent reversal of the normal diurnal oscillation of the barometer	Sir John Eliot.
On the rainfall of Benares considered in relation to the prevailing winds	S. A. Hill.
On the diurnal variation of the barometer at Indian stations, Part I, Calcutta and Hazaribagh Price Rs. 3*	Henry F. Blanford.
Part III, comprising—	
Variation of rainfall in Northern India	S. A. Hill.
Meteorological and hypsometrical observations in Western Tibet, recorded by Dr. J. Scully, with a discussion Price Rs. 3	Henry F. Blanford.
Part IV, comprising—	
The winds of Kurrachee Price Rs. 3	Fred. Chambers.
Part V, comprising—	
Some results of the meteorological observations taken at Allahabad during the ten years 1870—79	S. A. Hill.
The diurnal variations of the barometer at Indian stations, Part II, Goalpara, Patna and Leh Price Rs. 3	Henry F. Blanford.
Part VI, comprising—	
The Meteorology of the North-West Himalaya Price Re. 1	S. A. Hill.
Indian Meteorological Memoirs, Vol. II, containing :—	
Part I, comprising—	
Account of south-west monsoon storm of the 18th to the 24th of September, 1878, in the north of the Bay of Bengal	Sir John Eliot.
List of cyclones on the West Coast of India and in the Arabian Sea up to the end of year 1881. Price Rs. 2	Fred. Chambers.
Part II, comprising—	
Note on the foregoing list of cyclones and on the Gujarat land cyclone of July 11th to 13th, 1881	Henry F. Blanford.
On the temperature of North-Western India Price Rs. 2	S. A. Hill.
Part III, comprising—	
[illegible] monsoon storms of the 8th to the [illegible] the Bay of Bengal Price Rs. 2	Sir John Eliot.
Part IV, comprising—	
Account of south-west monsoon storms generated in the Bay of Bengal during the years 1877 to 1881 Price Rs. 2	Ditto.
Part V, comprising—	
Observations of temperature and humidity at a height of 40 feet above the ground at Alipore Observatory, Calcutta. Price Re. 1	S. A. Hill.
Indian Meteorological Memoirs, Vol. III, containing a full discussion of the rainfall of India and cognate subjects, complete in 4 parts Price, each part, Rs. 2*	Henry F. Blanford.
Indian Meteorological Memoirs, Vol. IV, containing :—	
Part I, comprising—	
[illegible] 13th to the [illegible] Akyab	Sir John Eliot.
[illegible]	Henry F. Blanford.
The meteorological features of the southern part of the Bay of Bengal Price Rs. 3*	W. L. Dallas.
Part II, comprising— [illegible] Price Rs. 2*	Sir Alexander Pedler.
[illegible] the old ob- [illegible] ice Re. 1-8*	S. A. Hill.
Part IV, comprising—	
[illegible] of the south-west monsoon storms [illegible] Bay of Bengal during the years 1882 to 1886 Price Rs. 3	Sir John Eliot.
Part V, comprising—	
[illegible] November, 1886, in the [illegible]	Ditto.
The cyclone of the 25th May to the 2nd June, 1881, in the Arabian Sea Price Rs. 3	Fred. Chambers.
Part VI, comprising—	
On temperature and humidity observations made at Allahabad at various heights above the ground Price Rs. 1-8	S. A. Hill.
Part VII, comprising—	
The Arabian Sea cyclone of the 4th to the 13th June, 1887	Fred. Chambers.
On the Meteorology and Climatology of Northern Afghanistan Price Re. 1-6*	W. L. Dallas.
Part VIII, comprising—	
An account of the more important cold weather storms in India during the years 1876 to 1891 Price Rs. 3*	Sir John Eliot.

* Copies of publications to the price of which an asterisk is appended are out of print.

† The Normal weather or pilot chart of the Indian monsoon area for 8 a.m. is a monthly publication. Copies for June, August and September, 1901, and January to October, 1902, and August to September, 1903, are out of print.

‡ Copies of the Reports on the Meteorology of India for the years 1875, 1876 to 1881, 1884, 1887 and 1890 are out of print.

¶ Copies of the India Weather Review—Annual Summary for the years 1891 to 1901, are out of print.

§ The Monthly Weather Review is a monthly publication continuously published about four months after the month. Copies of Monthly Weather Review for 1891—97, January, 1898, 1899, 1900, 1901, January to May, 1902, January to November (June excepted), 1903, and January 1904, are out of print.

Continued on page iii of this cover.

Kite flights in India and over the neighbouring sea areas during 1907. By J. H. Field, M. A., Imperial Meteorologist.

1. In July and August 1907 work with kites was resumed at Belgaum in the Bombay Presidency, and in late August and September some attempts were made to obtain records in the Bay of Bengal and Arabian Sea during the course of a passage to England on the B.I.S.S. "Dilwara." The apparatus used was the same as in August 1906 with the exceptions that kites and meteorographs of the Dines pattern were almost exclusively employed, and that at sea the wire winder was the hand machine of which a description has already appeared[1].

2. The work on land, at Belgaum, lasted from July 11th to August 3rd, but it was only during the first week of that period that successful flights were made. Weather had been nearly dry and winds light in the Peninsula for some time previous to July 11th, but from that day onwards the winds increased in velocity until on the 19th the monsoon had become re-established. It was found that, with this change in the weather, eddies of air had formed, similar to those which had been encountered in 1906 beyond the immediate site of the kite shed, and that they were now very pronounced and of great extent: as a consequence of these eddies it proved to be impossible after the 18th to launch kites even on a long line, without great risk of their immediate destruction[2]. In addition to the difficulty of launching, trouble arose from the fact that the winds, as they freshened, became exceedingly squally, so that after the 17th on all occasions when a successful start had been made, the kites were overtaken and broken up by rain squalls within a very short time.

Squally conditions, but of a less pronounced type, had been encountered during the kite work of 1906, and a description of the attendant difficulties was given in the published account of that work[3]. The recurrence of the trouble made it appear important to secure measurements of the variation of wind velocity near the ground during the passage of a rain squall, in order to ascertain whether the maximum velocities were so great that it would be useless to expect that kites of the usual pattern could be made sufficiently strong to be serviceable in an active monsoon.

For this purpose a Robinson anemometer was put up near the kite station, and observations were made at times of the passage of the rain squalls in its neighbourhood. The readings showed that winds which averaged about 11 m. p. s. during the day, and appeared favourable for the purposes of kite flying, would vary in velocity in the course of five or ten minutes from 8 m. p. s. as a rain squall was approaching, up to as much as 20 m. p. s. as its centre actually passed in the neighbourhood of the instrument. These measurements were made at a height of 1·5 m. above the ground, and it seems probable, therefore, that at a height of 100 m. or more the velocity of winds which had been found so destructive to kites may have reached 30 m. p. s. or more for short periods of a few minutes at times of their maximum effect. It would probably be very difficult

[1] Indian Meteorological Memoirs, Vol. XX, Part I.

[2] It became evident in the course of the work that the site of the kite shed was unsuitable, and arrangements have accordingly been made for removing it to a new position for work in 1908.

[3] Indian Meteorological Memoirs, Vol. XX, Part 2.

to make kites capable of withstanding winds of this strength and of remaining stable in flight; and even if this were done, their weight would perhaps be so great that but little chance would remain of reaching reasonable heights in the moderate winds which are prevalent between the squalls.

3. The unwelcome conclusion was suggested, therefore, that kite flying work in the monsoon was likely to be exceedingly difficult if the prevalence of these rain squalls should prove a characteristic feature of the rainfall of the period. At the end of the visit to Belgaum, however, while preparations were in hand for a return to Simla, the squally weather was followed by a period of much steadier but very strong winds, and it appeared quite probable that in such weather kite flying would have proved successful.

These steady and strong winds were associated with continuous and widespread rainfall which lasted until the 18th August. It is thus possible that squally weather may be a necessary accompaniment of the transition from the dry conditions of a "break" to the settled wet weather of a well established monsoon, and that when the monsoon has actually become well established the strong winds which are associated with it may prove sufficiently steady for successful kite flying.

4. The diagrams in Plates II and III show the results of kite flights in July. On the 14th of the month dry weather conditions were still prevalent and an inversion of temperature at 1 000 m. marked the lower limit of a region of dry air, but after that day no boundary of the lower damp stratum of sea winds was encountered by the kites. The maximum height attained increased with the rising winds of the period from about 1,500 m. on the 14th to 2,900 m. on the 17th, and by that morning the conditions of moisture had closely approached saturation and had become much steadier throughout the flight than during the preceding days.

This is evident on a comparison of the diagrams for relative humidity, figs. 7, 10 and 13, Plates II and III, in which most of the points are plotted in chronological order. It is there shown that the somewhat rapid fluctuations of humidity on the 15th and 16th, due perhaps to the passage of actual or incipient cloud masses, had largely disappeared by the next day. The 17th of the month, itself showery, was followed by a period of nearly continuous rainfall and of high winds, conditions entirely typical of an active monsoon.

5. The following table shows the temperature gradients and the changes of wind direction above the surface, which were found during the period covered by the flights. The changes of wind direction were all clockwise and have been recorded in the table as positive, Gradients of temperature for both the ascending and descending parts of the flights are given, but as the ascent was always considerably slower than the descent it is in the latter that the nearest approach to simultaneous records for the whole thickness of air traversed is to be found. Since the gradients near the ground surface are of necessity much influenced by the time of day and the kind of weather, the figures for the layer up to 400 m. have been separated in the table from those in the air at greater heights, where rapid fluctuations are not so likely to occur in the course of a single flight.

Table I.

Date.	Time.	Temperature gradient, °C per 100 m.		Stratum metres.	Change of wind direction from surface upwards.	Date.	Time.	Temperature gradient, °C per 100 m.		Stratum metres.	Change of wind direction from surface upwards.
		Ascent.	Descent					Ascent.	Descent.		
14th July 1907.	13¾h—17⅓h.	—2·4		0—400	Not observed						
		—0·43		400—1500		16th July 1907.	17½h—20¼h.		—0·54	1000—400	+40° from 0. *m.* to 1300 *m.*
	17⅓h.—18⅓h.		—0·61	1500—400					—1·4	400—0	
			—0·8	400—0							
15th July 1907.		—1·5		0—400	+17° from 0. *m.* to 1460 *m.*	17th July 1907.	11¾h.—16¾h.	—1·8		0—400	+30° from 0. *m.* to 770 *m.*
		—0·54		400—2000				—0·44		400—2900	
	15¾h—21h.		—0·38	2000—400			16¾h.—18¼h.		—0·43	1900—400	
	21h.—22¼h.		—0·3	400—0					—0·55	400—0	

During the ascent the gradients of temperature near the ground were, as might be expected, considerably greater than at the times of descent later in the day. The times of descent on the 14th, 15th and 17th were approximately the same, and the gradients found are therefore comparable without correction for diurnal changes: it appears, as far as the few available observations go, that the gradients from the top of each flight down to the 400 m. level, *i. e.* in the region removed from the influence of rapid changes in surface temperature, decreased steadily as the conditions for wet weather approached. Of the records obtained from the 14th to the 17th, that on the 15th shows from the highest point down to the ground level a smaller gradient than any of the other three, but as the descent was on that day some 3½ hours later in the evening than in the other cases, the results are not immediately comparable: the small gradient of 0·3° C. per 100 m, in the lowest 400 m. shows that the effect of surface cooling by radiation was by that time strongly felt.

6. The records obtained were unfortunately few, but as far as they go they appear to indicate conditions of which the following is a summary:—

(i) The wind velocity, estimated but not measured, did not increase on any one day to a noticeable extent with elevation during the period of transition between the dry conditions of the 14th and the wet weather which followed the 17th. After that date the velocity probably increased above the surface, but as all attempts to sail kites were unsuccessful, it is not possible to speak with certainty on this point.

(ii) The wind direction from the surface upwards, though varying little on the 15th, showed increasing rotation as the wet weather approached during the two succeeding days.

(iii) Temperature gradients near the ground were, during ascents, considerably greater than the adiabatic rate for unsaturated air even on the 17th, a showery day with the sky completely clouded; during descents later in the day the gradients in the same lower stratum were considerably smaller. At levels above 400 m. gradients during descent varied from *about*—0·4° *C. to*—0·6° *C.* per *100 m.*

(iv) An upper limit to the humid layer was reached only on the 14th, at the time when completely dry weather conditions still prevailed. It lay on that day at about 1000 m. above the surface, but if it persisted afterwards it must have risen considerably with the change of weather, for it was not again encountered by the kites although levels up to about three times that height were reached within the next few days.

BAY OF BENGAL AND ARABIAN SEA.

August 24th to September 4th.

BRITISH INDIA S. S. "DILWARA."

7. For the work at sea the winding machine was fixed on a boat deck in the after part of the vessel and the kite-wire was led through two loose pulleys, the further of which could be hoisted to the gaff half way up the mizzen mast. Although the space available for working was small and the boat deck much exposed, it was found *that by the use of the pulleys accidents to the kites at the critical times of launching* and landing could be fairly well guarded against.

The meteorographs measured pressure, temperature and humidity only, for no wind recording instruments of a type sufficiently inexpensive to be used at sea were available at the time. Consequently the deductions regarding the velocity of the wind depended only upon observation of the behaviour of the kites, and regarding the wind direction on measurements made by an altazimuth without correction for the component due to the ship's velocity.

8. During flights in the Bay of Bengal no question of estimating wind velocity or direction arose, for the air was practically calm at the surface, and it was recognised that the raising of the kite depended only on the virtual wind given by the ship's movement. In the Arabian Sea, also, no difficulty occurred in estimating true changes of wind direction above the surface, for since the wind on the 1st September was almost dead ahead, and that on the 3rd was only 15° on the bow, the unmeasured relations between the ship's speed and the true velocities of the strong upper winds could not on those days greatly prejudice deductions as to change of wind direction with height above the sea. This was not the case however on the 4th, a day on which a very abrupt change of 27° was found to occur at a height of about 1000 m. above sea. The surface wind was then 33° on the port bow, so that the rotation observed brought the kites more nearly into the

wake of the ship, then travelling on a course N 80° W. In these circumstances an apparent rotation of the kind observed, if caused by a change of wind velocity only, would of necessity imply a *diminution* of velocity in the upper strata. From the increasing pull given by the kites as they rose it is certain that no such diminution occurred, and that the rotation of the wind was a reality. Two kites were in use, and each passed at least twice through the 1000 m. level, and showed clearly that the rotation there was sudden and persistent.

9. Figs. 15 to 17 on Plate IV show the conditions met with on August 24th in the Bay of Bengal in position 21°N, 88°E, the place indicated by the circle in the sea area on Plate V. The total absence of wind other than that given by the ship's motion precluded the possibility of raising the kites to more than 600 m. The gradients of temperature shown by the figures are almost exactly adiabatic, while humidity, which was only 84% near the sea level, rose to a maximum of 95% near the 400 m. level and then began to decline.

10. In the Arabian Sea the ship's course lay through a region which is known to seamen as the "soft place" in the monsoon. This region, shown by the shaded area in Plate V is characterised by surface winds of only moderate strength, and even while a strong monsoon is giving a rough sea in the regions further to the north, and is drenching the west coast of the Peninsula with heavy rain, the skies of the "soft place" are clear or only lightly clouded, the sea is smooth, and rainfall is light or wanting.

11. The diagrams in figs. 18 to 23, Plate IV, represent the temperature and humidity conditions met with on September 1st and 3rd, on the former date up to a height of about 2800 m. in position 8°N, 75° E, and on the latter up to 1200 m. in position 9° N, 65° E. These places in the Arabian Sea are among those indicated by circles in Plate V. The most westerly circle represents the position of the ship on the 4th, a day for which only wind observations and no temperature or humidity diagram is available. The want of information on this day is due to the fact that after rising to a height of nearly two miles, as calculated from sextant readings and length of wire, the kites became fractured in the air under heavy and increasing wind pressure, and finally were carried away. At this time there had begun in India a "break" in the rains which ultimately proved to be the complete and early withdrawal of the monsoon, probably the most marked meteorological feature of the year.

12. The variations of the wind direction on these three days of observation are shown in the following table, where a clockwise change of direction is taken to be positive. Wind directions at sea level were estimated, after the manner of sailors, by the directions of advance of the smallest wave fronts, so that no consideration of the ship's course and velocity was involved.

TABLE II.

Approximate height above sea. metres.	September 1st — Position 8° N, 75° E. Direction.	September 1st — Change from direction at sea level.	September 3rd — Position 9° N, 65° E Direction.	September 3rd — Change from direction at sea level.	September 4th — Position 10° N, 61° E. Direction.	September 4th — Approximate change from direction at sea level.
Sea level ...	N 68° W becoming N 55° W.	......	S 85° W° ...	......	Wind S20° W approximate Azimuth of kites 67° W.	......
900 ...	......	......	......	......	Azimuth of kite S 59° W.	......
1,000 ...	N 68° W ...	0°	......	......	......	......
1,100 ...	......	......	S 85° W ...	0°	......	......
1,200 ...	N 74° W ...	—6°	......	......	......	
1,300 ...	......	......	......	......	Wind and Azimuth of kite S 86° W.	+66°
1,500 ...	......	......	......	... ..	Wind and Azimuth of kite S 82°.	+62°
1,750 ...	W	—22°	......	......	......	......
1,900 ...	......	......	......	......	Wind and Azimuth of kite W.	+70°

Over the area traversed between the 1st and the 4th the normal surface winds vary from about N 60° W on the eastern edge to about S 40° W on the western. During the passage the surface winds were found to have nearly these normal directions, yet at a height of 1800 m. an almost due west wind was encountered on each of the three occasions when ascents were made.

13. The following short table shows the temperature gradients found in the Bay of Bengal on the 24th August, and in the Arabian Sea on the 1st and 3rd of September.

TABLE III.

Date.	Time.	Position.	Stratum. metres.	Gradient° C. per 100 m.
24th August ...	13½h. to 14h	BAY OF BENGAL. 21°N., 88° E.	0—600	—1·05
1st September ...	9h to 15h.	ARABIAN SEA. 8° N, 75° E.	0—400 400—2,800	—1·05 —0·51
3rd September ...	13h to 17h	9° N, 65° E.	0—400 400—1,200	—1·00 —0·64 decreasing.

14. The preceding account of the wind observations, and the information given in figs. 18 to 23, Plate IV, where the wind direction, temperature and humidity have been plotted, indicate that the following conditions held over the area in question in the Arabian Sea :—

(1) The velocity of the wind increased appreciably with height, and in direction the wind varied in such a manner as to become due west at a height of 1800 m. irrespective of the direction of the surface wind.

(2) Temperature gradients were very nearly adiabatic up to a height of about 500 m. above sea, and thereafter decreased to about half that rate. No inversion occurred.

(3) Absolute humidity remained sensibly constant from the sea level up to a height of 400 m. on all days, and above that level it steadily decreased to quite low values. None of the extremely abrupt changes from wet air to dry were encountered, such as in India have been found to be a characteristic condition over the land area on all occasions when a stratum of great dryness has been reached.

In the case of the flight in the Bay of Bengal, figs. 15 to 17, Plate IV, the results, as far as they go, appear to indicate that conditions similar to those of (2) and (3) held in that region also.

Appendix No. 1.

A NEW FORM OF METEOROGRAPH AND OTHER APPARATUS FOR USE WITH KITES.

1. The large and rapid changes of air temperature which take place during the course of the day in India make the results of kite flights, as far as they relate to temperature gradients, to some extent uncertain, for the reason that in a flight of average duration, perhaps four or five hours, the temperature registrations are not even approximately simultaneous for all the strata passed through.

With a view of overcoming this difficulty, and securing temperature records for all the lower strata within a period of about half an hour, it was decided last year to construct a light meteorograph and mount it upon a suitable traveller which should be blown by the wind along the kite-wire up to the kite, after the manner of the paper messenger which is sent up a kite-string by boys. On reaching the kite the traveller was to be made to throw away its sail and descend with the instrument to the operator, who would then have secured two independent records up to the level of the kite within a comparatively short time.

2. The result of the first experiments in making a traveller and light meteorograph was to produce an outfit, Plate 6, figs. 25 and 29, weighing about 0·7 kilogramme, of which the meteorograph weighs 120 gr.

The traveller, fig. 25, consists of a light bamboo stem about five feet long, provided at each end with an aluminium wheel to run upon the kite-wire With the wheel brackets shown in the diagram it is necessary to remove the spindles when hanging the traveller on to the kite-wire, but the brackets have since been modified to allow of the rapid application of the traveller to the kite-wire, and of removal from it, without a chance of accidental disengagement during use.

3. A fine steel wire (*a*) threads the hollow bamboo stem from end to end, and in front is attached to a detent (*b*) which passes through guide plates (*jj*), and is held forward by the trigger (*c*) until an impact on the latter releases it. At the back end the wire is attached to a lever (*d*) normally drawn backwards by a spiral spring (*e*), but held forwards by the steel wire when the trigger has been set. The lever (*d*) engages by a roller (*l*) with a forked arm (*f*) in such a way that when the trigger is set the forked arm is held rigidly with the opening of its fork pointing backwards. A brass wire loop (*g*) engages in the fork and is attached to four diverging sail strings, two of which pass forwards over very short wire projections at the ends of the flexible cross boom, (*h*) fig. 25, and are attached to the upper hem of the sail. The remaining two strings are fastened to the lower hem of the sail at the ends of a very light slip of wood which traverses the hem and serves to prevent the sail from flapping. When the sail has been hooked on to the boom and the wire loop at the junction of the strings placed in the opening of the fork, the trigger can be set by pushing forward the detent (*b*) by means of the projecting stud (*k*). The length

of the upper strings is such that when the sail is attached the boom is slightly bent backwards at its ends, and as the strings are then in tension they have no tendency to slip out of place. The lower pair of strings remains loose and serves merely to keep the sail well in the wind.

The recording instrument is fastened rigidly below the back end of the bamboo stem, and the whole apparatus, after being hung upon the kite-wire, is let free in the wind. All that is necessary then to ensure its return after reaching the highest point desired, is to have fixed at that point upon the kite-wire below the kite a plate or other body against which the forward pointing trigger can release itself when impact occurs. When this release has taken place the axial steel wire is set free and allows the spring (*c*) to draw back the lever (*d*) and disengage it from the fork. This is then rotated by the pull of the sail-strings until the opening of the fork is reversed in direction and allows the sail and its strings to become disengaged from the traveller and fly away, the traveller itself returning down the wire to the operator. In fig. 28 the tail fixture is shown just after the release of the trigger; the forked lever (*f*), now disengaged from lever (*d*), is in the act of turning forwards to release the wire loop (*g*).

4. The form and attachment of the impact plate at the top of the wire were found to need some experimenting before a satisfactory result was obtained; it was necessary to arrange that the impact, while sufficient to release the trigger, should not be violent enough to jerk the whole apparatus and damage the meteorograph or spoil its record by vibration. The form found to be most suitable is that of an aluminium disc (*r*) fig. 25, 13 cm. in diameter, slotted radially to its centre to allow of its being threaded on the kite-wire. Two lugs are punched out of it near the centre and turned backwards at right angles to the plane of the plate, and through holes in them a two inch piece of copper wire is passed and bent down at its ends beyond the lugs and above the kite-wire after this has been passed down the slot to the centre of the plate. The plate then lies loosely on the kite-wire and is prevented from falling off by the copper wire key-piece. Fastened to the back of the metal plate is a framework of thick iron wires which meet and are joined together at about 15 cm. behind the plate. From this junction extends a tail-piece consisting of a single thick wire about two feet long, turned up at each end as shown in fig. 25. After hanging the plate upon the wire, this tail-piece is twisted round the latter and secures the plate with its plane normal to the kite-wire.

The attachment by a twisted wire is thus similar to that which has been used by Mr. Dines in England for fixing supplementary kites to his main kite-wire.

5 The whole impact arrangement of plate and wire tail can then slide along the kite-wire more or less freely according to the number of half turns by which the tail is twisted round the kite-wire. In this way it can be arranged that the stoppage of the traveller and its meteorograph takes place gradually and not with a violent jerk, the plate being pushed along the kite-wire and gradually stopping the traveller in any desired short length of time after impact. A similar plate is fixed upon the lower end of the kite-wire near the reel, to catch and stop the traveller gently on its descent.

In practice it has been found best to attach the lower stop immediately after despatching the traveller on its upward journey; and when the descent is nearly complete and the traveller within 100 m. of the reel, to let out the kite-wire quickly and stop it when the check plate has travelled about 20 m. away from the winding machine. This action not only provides a distance of 20 m. in which the traveller may come to rest without fear of crashing into the reel, but by suddenly reducing the upward angle of the kite-wire at its lower end assists naturally in diminishing the speed of descent as the check-plate is actually approached.

6. The meteorograph, fig. 29 and (m) in fig. 25, records temperature, pressure and humidity, marking by hardened steel points on the surface of a silver-coated glass plate. The plate is rotated by the works of a cheap watch, which has been lightened by the removal of all unnecessary parts. The holder (*n*) for the glass plate fits on the spindle of the minute hand and consequently rotates once in an hour; then, as the whole of the ascent of the instrument and its subsequent descent can conveniently be made to take place well within 20 minutes, it is possible by disposing the marking points of the three recording pens at time angles of 20 minutes apart on the silvered glass, to utilise for each flight almost the whole circumference of the diagram without risk of confusion from superposition of the records.

7. The pressure of the pens on the glass is adjustable by the back screws (pp), and in working is made exceedingly light; it has been estimated by comparison with a finely divided millimeter scale under a low power of the microscope that when the pens are freshly ground the marks made by them need not be thicker than about one five hundredth of a millimeter. It appears, however, that unless the pens are carefully adjusted to give the minimum serviceable pressure on the plate, their points are liable to thicken rapidly and to produce coarser records than are desirable. The pens can be re-sharpened by a slip of fine Arkansas oilstone even without removing the part of the instrument to which they are attached.

So fine a line as one five hundredth of a millimeter thickness on a thinly coated silver surface is difficult to see by the naked eye, but under the microscope the record is exceedingly sharp and clear.

8. Under calibration the instrument illustrated gave the following scale:—

Movement of pressure	pen	1 m. m. =	change of pressure of	88·5 mm. mercury.
,, ,, temperature	,,	1 m. m. =	,, ,, temperature	21·8° C.
,, ,, humidity	,,	1 m. m. =	,, ,, humidity	55%

The humidity scale could have been made more open without trouble, and in the case of the aneroid the results of subsequent experiments with varying shapes of exhausted pipes showed that no difficulty need be experienced in increasing the scale considerably without increasing the size of the instrument.

On the assumption that the meteorograph will not under extended trial show troublesome changes of the zeros of its pens, it appears that it ought to be possible to read the records satisfactorily under the microscope to 0·5 mm. of pressure, *i.e.*, to 5 m. of height at sea level, and to 0·1° C.

9. As regards the cost of the instrument it seems probable, judging by the time taken in making the first one in Simla, that if a stock pattern were to be adopted, the value of the workmanship and material, inclusive of a Rs. 3 watch, would be about Rs. 12.

10. It was at first thought that trouble would arise from a blurring of the records if the speed with which the traveller was required to run along the wire should be sufficient to cause vibration, especially when passing over splices; but during actual trials last year at Belgaum and in the Arabian Sea no such difficulty was found. In the Arabian Sea a satisfactory record up to a height of about three-quarters of a mile was obtained, when the mean speed along the wire during ascent and descent was about 8 m. per second, and there appears to be no reason for desiring a greater velocity than that.

11. The records are to be read under the microscope by a low power eyepiece containing a micrometer scale. For this purpose it has been necessary to arrange for stage adjustments which allow of the centering of the plate to turn about its original axis, and for further rotational movements by which the plate may be rapidly turned between checks while under inspection, from any point on the pressure record to simultaneous points on the temperature and humidity records. The design of such a stage for the microscope has presented no difficulty and need not be further detailed here.

12. The meteorograph and traveller in their present state of development are defective in several respects, chiefly on account of their too great weight, and are certainly capable of much improvement with comparatively little expenditure of time on further actual tests. The trial of the outfit was first made in July 1907, nearly nine months ago, and promised well, but as no opportunity for further tests has since occurred or is likely to occur for many months it appears to be worth while to publish a description of it now in case it may be useful to others, and not to await a later occasion for determining the best and lightest form to employ.

Appendix No. 2.

1. The following are the tables of figures from which the diagrams in Plates II to IV have been plotted. Most of the points on the diagrams are joined up in chronological order; in each figure the series of points from the beginning of the flight up to the time of maximum altitude are joined up by thick lines, and from that time until the end of the flight by thin lines.

2. The line *dc* shows in each case the adiabatic temperature gradient for unsaturated air. Time is Indian Standard Time throughout.

Belgaum.

July 14th, 1907.

PLATE II.

Wind.—Average wind for 24 hours at 15 m. above ground 4 m. p. sec.

Wind direction S 67° W.

Cloud.—Cu 2—6.

Weather.—Dry.

Maximum height.—1485 m.

Duration.—5·2 hours.

Time.		Height, metres.	Temperature, °C.	Humidity.		Remarks.
				Relative, %	Absolute, grams per cubic metre.	
H.	M.					
13	13½	0	31·5	63	20·5	
	37	245	23·8	78	16·6	
	51	470	21·8	92	17·3	
14	13	635	20·3	100	17·4	Under Cu.
	28½	705	20·2	100	17·3	" "
	47	775	20·0	100	17·1	In Cu.
	53	870	19·5	95	15·8	In and out of Cu.
15	02	1275	18·5	100	15·7	
17	19	1455	17·7	94	14·0	
	23	1485	17·3	63	9·2	
	36	1265	18·5	60	9·4	
	39	1180	18·0	69	10·5	
	43	1140	17·2	84	12·1	
	46	1000	16·6	95	13·3	
	55	535	19·6	95	15·9	
	59½	670	18·7	95	15·0	
18	11	260	21·2	91	16·7	
	25	0	23·4	78	16·2	

July 15th, 1907.

PLATE II.

Wind.—Average wind for 24 hours at 15 m. above ground 5 m. p. sec.

Wind direction.—S70°W.

Cloud.—Ci and light Ci. 10.

Weather.—Showery.

Maximum height.—2040 m.

Duration.—5·4 hours.

Time.		Height, metres.	Temperature, °C.	Humidity.		Remarks
				Relative, %	Absolute, grams per cubic metre.	
H.	M.					
15	46½	0	26·5	85	21·1	Wind S70° W.
...		180	...	...	...	Wind S67° W.
16	10	280	20·8	96	17·2	
	12	435	20·3	85	14·8	
17	20	455	18·7	96	15·2	Wind S78° W
	33	630	17·5	94	13·9	In and out of clouds.
	41	945	16·5	96	13·3	
18	21	840	...	...	...	Wind S82° W.
	36	1125	15·5	94	12·3	
	46	1205	14·8	94	11·8	
	49	1460	...	...	...	Wind S87° W.
	52½	1575	13·5	83	9·6	
19	00	1565	13·3	83	9·5	
	07	1305	14·4	85	10·4	

PLATE II—(*contd.*)

Time.		Height, metres.	Temperature, °C.	Humidity. Relative, %	Humidity. Absolute, grams per cubic metre.
H.	M.				
19	10½	1465	14·6	73	9·1
	57	1825	12·7	79	8·7
20	18	1835	12·2	96	10·3
	47	1930	11·7	90	9·4
21	01	2040	11·1	90	9·0
	19	1610	12·8	90	10·0
	21½	1800	12·8	73	8·1
	38	1225	14·0	89	10·6
	41	1130	14·8	78	9·8
	42	1035	15·0	88	11·2
	44½	915	16·0	73	9·8
	50	835	16·1	93	12·6
	58	480	17·0	100	14·3
22	06	215	18·0	100	15·2
	10	0	18·4	100	15·6

July 16th, 1907.

PLATE III.

Wind.—Average wind for 24 hours at 15 m. above ground 6·3 m. p. sec.

Wind direction.—S67°W changing to W.

Cloud.—Cu, Cu-st; A-cu, varying.

Weather.—Showery.

Maximum height.—2165 m.

Duration.—3·1 hours.

Time.		Height, metres.	Temperature, °C.	Humidity. Relative, %	Humidity. Absolute, grams per cubic metre.	Remarks.
H.	M.					
11	51	0	...	...	...	Wind S67°W.
12	30	400	...	...	...	" W.
13	00	600	...	...	...	" N77°W.
15	40	1570	...	...	...	" S87°W.
17	12	2070	6·0	83	6·5	
	25	2165	4·8	86	6·7	
18	52	1970	6·7	89	7·3	
19	13	1635	8·5	83	7·7	
	19	1505	7·7	75	6·6	
	21½	1395	9·8	73	7·3	
	43	1140	10·7	75	7·9	
	51	1325	11·2	75	8·2	

PLATE III—*contd.*

Time.		Height, metres.	Temperature, °C.	Humidity. Relative, %	Humidity. Absolute, grams per cubic metre.	Remarks.
H.	M.					
19	57	1005	11·8	92	10·4	
20	08	615	13·5	92	11·5	
	15	295	14·8	94	12·8	
	19	0	20·0	94	17·3	

July 17th, 1907.

PLATE III.

Wind.—Average wind for 24 hours at 15 m. above ground 7·2 m. p. sec.

Wind direction.—S45°W changing to S80°W.

Cloud.—St-cu 10.

Weather.—Rainy.

Maximum height.—2895 m.

Duration.—6·1 hours.

Time.		Height, metres.	Temperature, °C.	Humidity. Relative, %	Humidity. Absolute, grams per cubic metre.	Remarks.
H.	M.					
11	44	0	25·3	83	19·2	Wind S45°W.
12	00	215	...	...	...	Wind S65°W.
	03	250	...	...	...	In clouds.
	10	320	...	...	...	Wind S71°W. Raining hard.
	15	425	17·5	96	14·2	
	40	770	...	...	...	Wind S75°W.
	48	1020	14·0	96	11·5	
	50	1150	...	...	...	Wind S71°W.
13	12	1705	13·1	96	10·8	
	28	1515	12·1	96	10·2	Raining hard.
	53	1920	10·5	96	9·2	
14	23	2165	11·2	96	9·7	
	55	2370	9·0	96	8·4	
15	40	2670	6·9	98	7·3	
16	35	2855	5·5	100	7·0	
	43	2895	5·2	100	6·8	
	45	2400	7·8	100	8·1	
	55	2510	6·6	100	7·5	
17	00	2300	...	...	...	Wind N85°W.
	05	1830	8·8	100	8·6	Wind not observed.
	15	2170	8·8	90	7·8	
	52	600	16·0	90	12·2	
18	20	0	19·4	100	16·5	Wind S80°W.

BAY OF BENGAL.

August 24th, 1907.

21° N, 88° E. 1 Kite.

PLATES IV AND V.

Wind.—Calm; ship's motion only, 6.2 m p s.
Cloud.—Str. 10 stationary.
Weather.—Some rain.
Maximum height.—570 m.
Duration.—0·5 hour.

Time	Height, metres	Temperature, °C.	Humidity. Relative, %	Absolute, grams per cubic metre
H. M.				
13 33	0	28·5	84	23 2
45	195	26 5	89	22 1
47	245	25 5	95	22 2
57	545	23 0	94	19 2
58	570	21 7	94	18 8

Arabian Sea.

September 1st, 1907.

5 N, 75 E 2 kites

PLATES IV AND V.

Wind.—Very light at sea level, strong in higher strata.
Wind direction.—At sea level N 65° W, at 1750 m due W.
Cloud.—Ci Str 8 (increasing in density), Cu 2.
Weather.—Fine
Maximum height.—2745 m.
Duration.—6 hours.

Time	Height, metres	Temperature, °C.	Humidity. Relative, %	Absolute, grams per cubic metre	Remarks.
H. M.					
8 53	0	27·0	80	20 3	
9 05	100	24·5	91	20 1	Wind N 65° W.
17	355	23 0	100	20 4	
23	435	21 7	99	18 7	
57	610	21 0	95	17 2	
10 00	850	20 2	91	15 7	
01	905	20 1	78	13 4	
09	1,075	19·3	80	13·1	Wind N 65° W
10		..	..	.	Above small Cu clouds.
13	1,270	18 7	80	12 7	Wind N 74° W.
23	1,350	18 3	84	13·0	
42	1,445	17 7	87	13·0	
11 10	1,550	16 3	87	12·3	
19	1,750	...	...	...	Wind W.
25	2,010	14·1	80	9 6	
11 27	2,040	14·1	74	8 9	
43	2,350	13 2	67	7·6	
12 04	2,415	12·5	78	8 5	
10	2,430	12 3	76	8 2	
21	2,705	10 9	60	5·9	
30	2,610	11 0	56	5·6	
39	2,745	10 5	45	4·3	
13 38	1,310	17 8	87	13 1	
55	1,130	18 0	97	14·8	
14 16	820	20 0	90	15·4	
26	590	21·3	86	15·9	
30	435	22·3	100	19 6	
59	0	25 9	78	18·7	

September 3rd, 1907.

9 N, 65°E 1 Kite.

PLATES IV AND V.

Wind.—Very light.
Wind direction.—From sea level upward S 85° W.
Cloud.—Cu 2, decreasing
Weather.—Fine.
Maximum height.—1175 m.
Duration of descent.—0 7 hour.

Time	Height, metres	Temperature, °C	Humidity. Relative, %	Absolute, grams per cubic metre.	Remarks.
H. M.					
16 22	1,175	17·8	79	11 8	
25	1,115	18·0	91	13 8	Wind S 85° W.
29	955	18 8	93	14·9	
38	790	19 9	93	15·8	
40	650	20·5	99	17·4	
45	450	22 3	99	19·4	
17 06	0	27 0	76	19 4	Wind S 85° W.

September 4th, 1907.

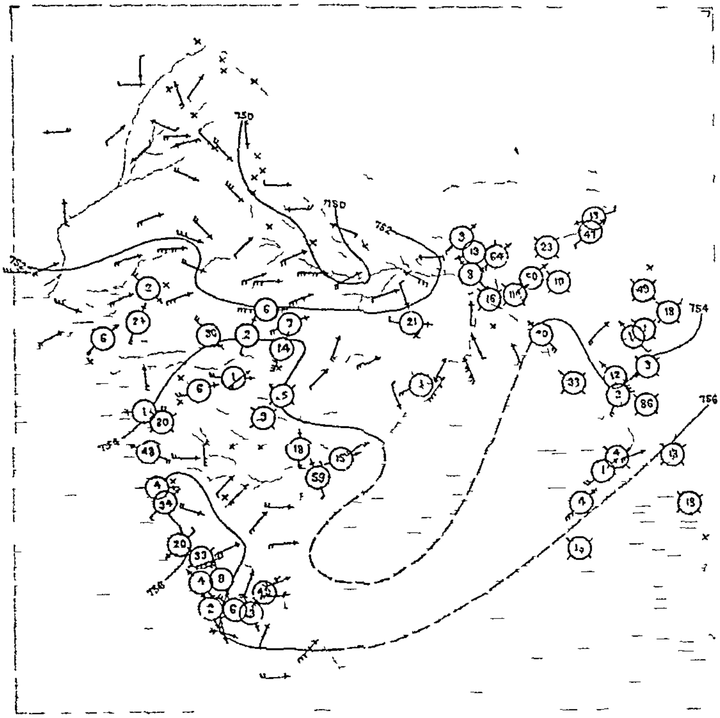
10° N, 61°E 2 KITES.

Plate V.

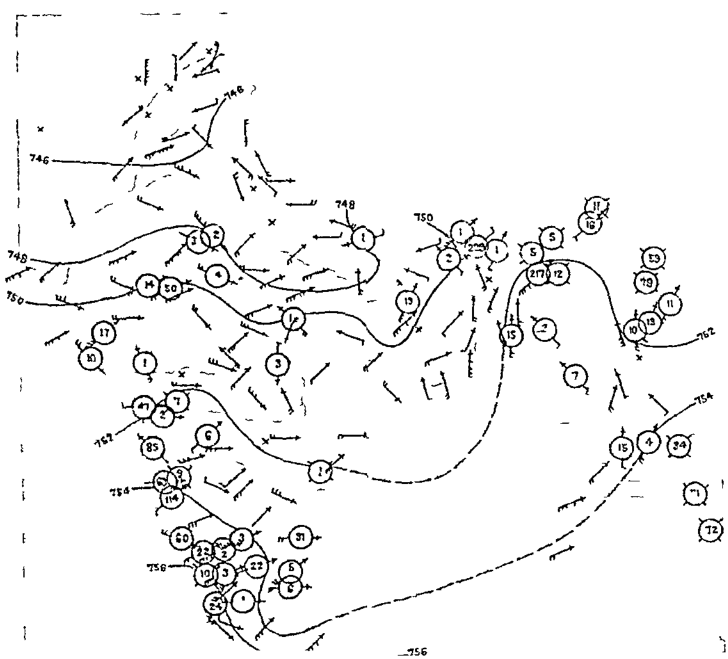
Wind.—Very light
Wind direction at sea level . . about S 20° W.
Azimuth kite ,, ,, ... ,, S 67° W.
,, ,, at 900 m. ... ,, S 59° W.
Wind and azimuth at 1,300 m. ... ... ,, S 8° W.
,, ,, ,, at 1500 m. ... ... ,, S 8° W.
,, ,, ,, at 1900 m. ... ... ,, W.
Clouds.—Acu moving from ... ... N 80° W.
Weather.—Fine.
Record.—None, kites carried away in strong upper winds.

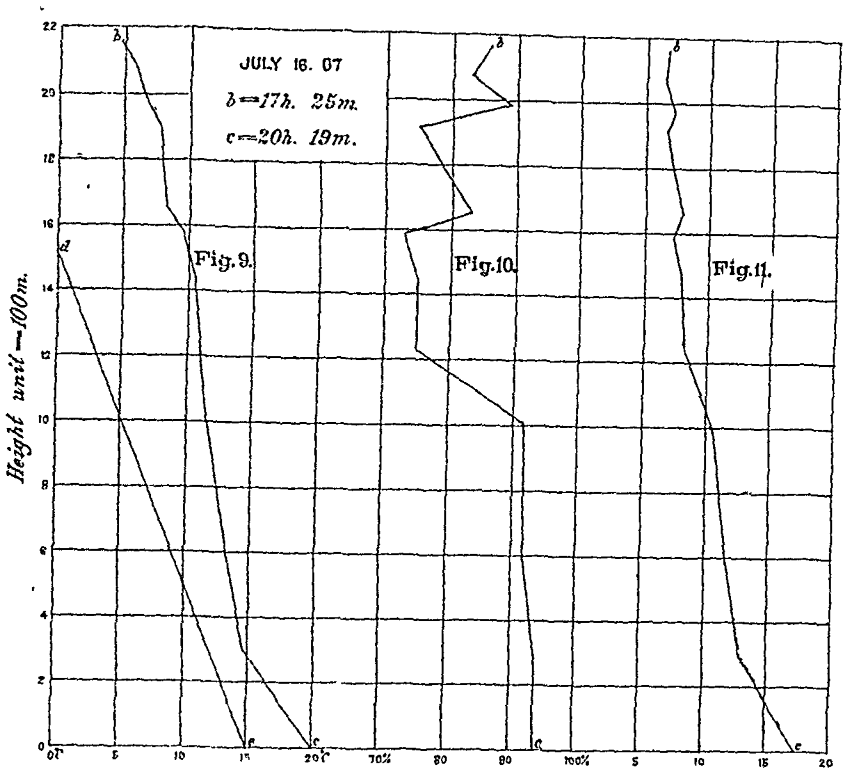
G C. B. P, Simla.—No. 167 M. R. G. I—3-9 08—370.—N.O.

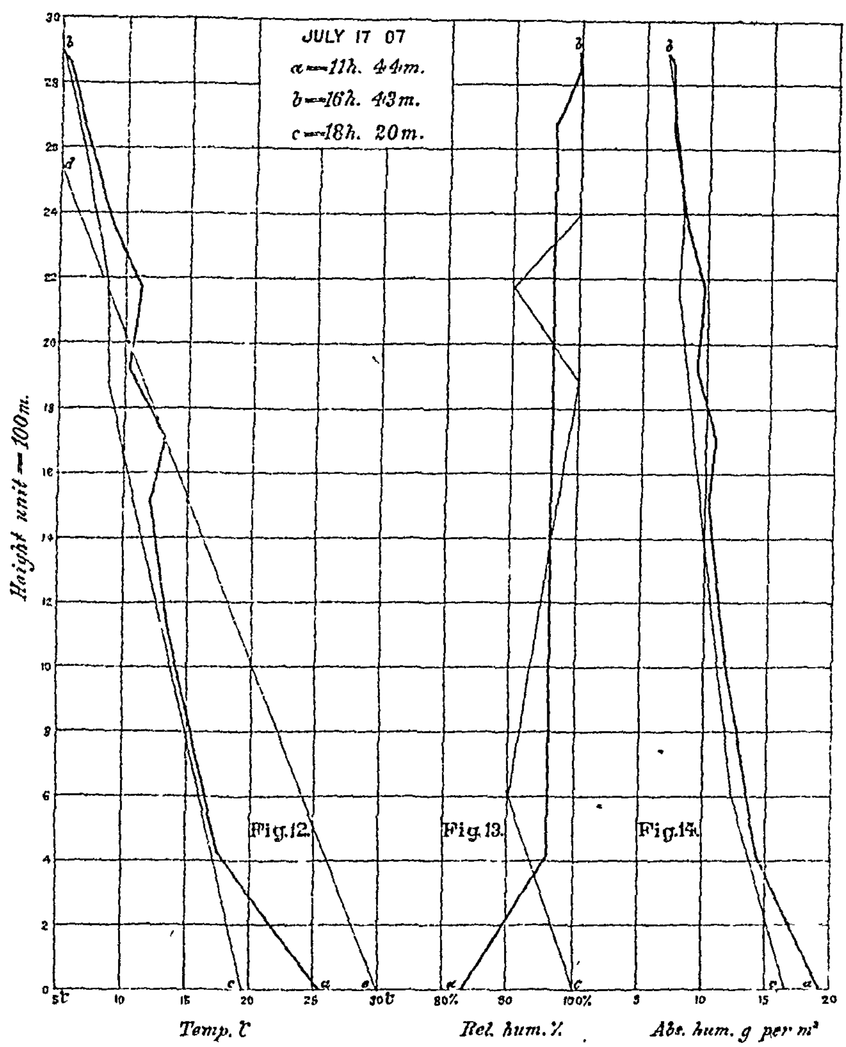
PRESSURE IN MM. AND WINDS AT 8 H ON 14TH JULY 1907
WITH RAINFALL IN MM OF ENSUING 24 HOURS

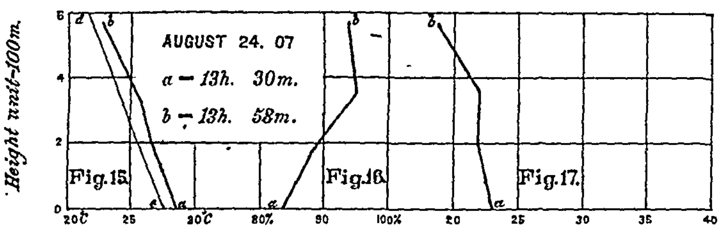


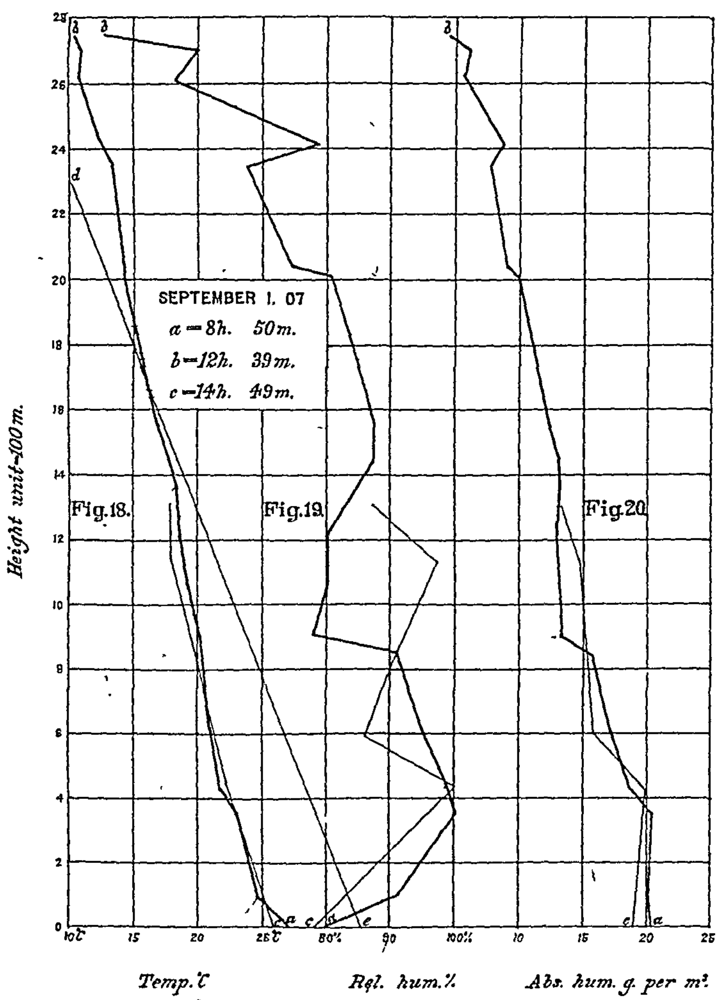
PRESSURE IN MM. AND WINDS AT 8 H ON 17TH JULY 1907
WITH RAINFALL IN MM. OF ENSUING 24 HOURS.

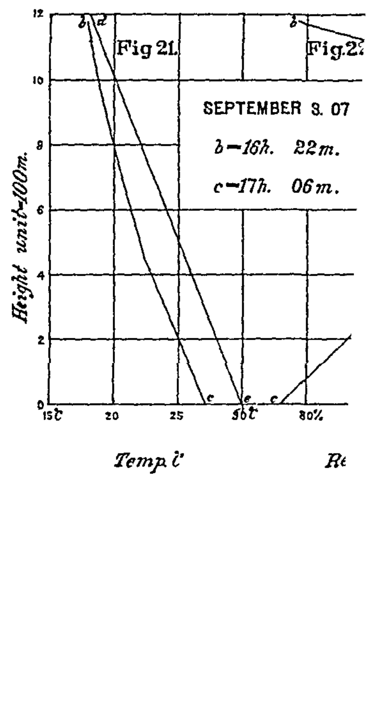


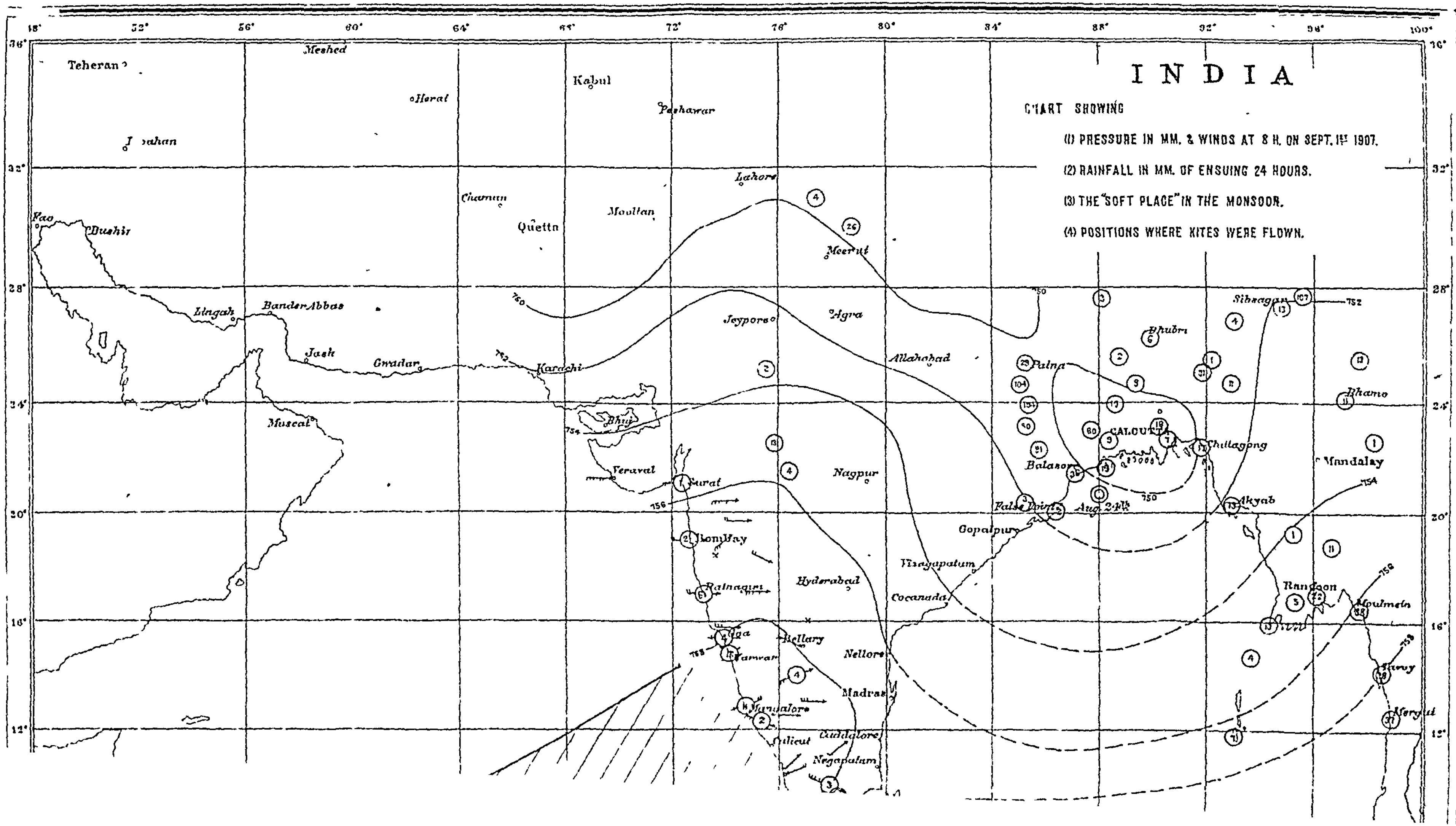

JULY 16. 07
b=17h. 25m.
c=20h. 19m.
Fig. 9.
Fig. 10.
Fig. 11.
Height unit = 100m.


JULY 17 07
a=11h. 44m.
b=16h. 43m.
c=18h. 20m.
Fig. 12.
Fig. 13.
Fig. 14.
Height unit = 100m.
Temp. C
Rel. hum. %
Abs. hum. g per m³


Height unit-100m.
AUGUST 24. 07
a — 13h. 30m.
b — 13h. 58m.
Fig.15.
Fig.16.
Fig.17.
20°C 25 30°C 80% 90 100% 20 25 30 35 40


Height unit-100m.
SEPTEMBER 1. 07
a — 8h. 50m.
b — 12h. 39m.
c — 14h. 49m.
Fig.18.
Fig.19.
Fig.20.
10°C 15 20 25°C 80% 90 100% 10 15 20 25
Temp. °C
Rel. hum. %
Abs. hum. g. per m³


Height unit-100m.
Fig 21.
Fig.2
SEPTEMBER 3. 07
b — 16h. 22m.
c — 17h. 06m.
15°C 20 25 30°C 80%
Temp. °C
Re


INDIA
CHART SHOWING
(1) PRESSURE IN MM. & WINDS AT 8 H. ON SEPT. 1st 1907.
(2) RAINFALL IN MM. OF ENSUING 24 HOURS.
(3) THE "SOFT PLACE" IN THE MONSOON.
(4) POSITIONS WHERE KITES WERE FLOWN.
Teheran
Meshed
Herat
Kabul
Peshawar
Quetta
Moultan
Lahore
Meerut
Agra
Jeypore
Allahabad
Patna
Bhubri
Sibsagar
Bhamo
Mandalay
Calcutta
Chittagong
Balasore
False Point
Akyab
Aug. 31st
Gopalpur
Vizagapatam
Cocanada
Nagpur
Hyderabad
Bellary
Nellore
Madras
Cuddalore
Negapatam
Mangalore
Karwar
Goa
Ratnagiri
Bombay
Surat
Veraval
Bhuj
Karachi
Gwadar
Jask
Bander Abbas
Lingah
Bushir
Fao
Muscat
Rangoon
Moulmein
Tavoy
Mergui
750
752
754
756
758

Indian Meteorological Memoirs, Vol. V, containing :— The discussion of the hourly observations made at Sibsagar, Goalpara, Patna, Hazaribagh, Dhubri, Roorkee, Allahabad, Lucknow, Agra, Leh, Deesa, Kurrachee, and Lahore and at Simla. Complete in 10 parts . Price, each part, Re. 1*	Parts I—VII. Henry F. Blanford. Parts VIII—X, Sir John Eliot.
Indian Meteorological Memoirs, Vol. VI, containing :—	
Part I, comprising— The relation between sunspots and weather as shown by meteorological observations taken on board ships in the Bay of Bengal during the years 1856 to 1879	W. L. Dallas.
Investigation into the mean temperature, humidity and vapour tension conditions of the Arabian Sea and Persian Gulf . . . . Price Rs. 2*	Ditto.
Part II, comprising— A preliminary discussion of certain oscillatory changes of pressure of long period and of short period in India. Price Re. 1*	Sir John Eliot.
Part III, comprising— The hot winds of Northern India	Ditto.
An account of a storm developed in equatorial regions. Price Rs. 2*	W. L. Dallas.
Part IV, comprising— Hailstorms in India during the period 1883—1897 with a discussion on their distribution . . . . Price Re. 1*	Sir John Eliot.
Part V, comprising— A discussion of the anemographic observations recorded at Simla during the period September, 1893, to August, 1896, [illegible] 5, to December [illegible] al features of area. Price Re. 1*	Ditto.
Part VI, comprising – A discussion of the anemographic observations recorded at Darjeeling during the period May, 1885, to May, 1896, and an investigation into the general features of the air movement in the Sikkim Himalayas . . . Price Re. 1*	Ditto.
Part VII, comprising— A discussion of the thunderstorm observations recorded in 1897 at ten selected stations in India . . Price Re. 1	W. L. Dallas.
Indian Meteorological Memoirs, Vol. VII, containing :— Hourly observations of pressure, temperature, vapour tension, humidity, cloud, wind direction and velocity of wind taken at Trivandram during the years 1853 to 1864. Complete in 7 parts . . . . . . Price, each part, Re. 1-8	Sir John Eliot
Indian Meteorological Memoirs, Vol. VIII, containing :—	
Part I, comprising— Hourly meteorological observations recorded at the Agustia observatory during the period from January, 1856, to September, 1858, and from June to December, 1864. Price Rs. 2	Ditto.
Part II, comprising— Hourly comparative meteorological observations taken at Trivandrum, Vannatheertham (eastern station), Kalliad [illegible] o periods 23rd March to [illegible] 9th February, 1859, 9th [illegible] 2nd to 28th January, 1855, also at Cape Comorin from 23rd September to 13th November, 1858, and at Charatha and Kamala from 20th January to 19th February, 1859 . . . Price Re. 1	Ditto.
Indian Meteo[illegible], Vol. IX, containing :— The diurnal [illegible] Cattack, J[illegible] Bellary, Trichinopoly, Rangoon, Aden, Alipore and Jaipur. Complete in 9 parts . . . Price, each part, Re. 1-8*	Part I, Henry F. Blanford. Parts II—VII, and IX, Sir John Eliot Part VIII, Douglas Archibald.
Indian Meteorological Memoirs, Vol. X, containing :—	
Part I, comprising— The discussion of the hourly meteorological observations recorded at Trivandram during the years 1853—1864. Price Rs. 3	Sir John Eliot.
Part II, comprising— The discussion of the hourly meteorological observations recorded at Agustia during the years 1856—1858 and 1864. Price Rs. 2	Ditto.
Part III, comprising— Discussion of the comparative hourly meteorological observations recorded at Trivandram, Kalliad, Vannatheertham and Agustia for the periods 23rd March to 20th April, 1857, 20th January to 19th February, 1859, 9th September to 8th October, 1864, and 2nd to 28th January, 1865, and at Charatha and Kamala from 20th January to 19th February, 1859. Price Rs. 2*	Ditto.
Indian Meteorological Memoirs, Vol. X, containing :— Part IV, comprising— Plates I to LVII, title page, table of contents and corrigenda of Volume X, Parts I, II and III of the Indian Meteorological Memoirs . . . . . . Price Rs. 3	Sir John Eliot.
Indian Meteorological Memoirs, Vol. XI, containing :— Part I, comprising— Observations recorded during the solar eclipse of 22nd January, 1898, at 154 meteorological stations in India. Price Re. 1*	Ditto.
Part II, comprising— A discussion of the observations recorded during the solar eclipse of 22nd January, 1898, at 154 meteorological stations in India . . . . Price Rs. 3*	Ditto.
Part III, comprising— Report on cloud observations and measurements in the plains of the North-Western Provinces of India during the period December, 1898, to March, 1900 . . Price Re. 1*	E. G. Hill.
Indian Meteorological Memoirs, Vol. XII, containing :— Part I, comprising— A discussion on the failure of the south-west monsoon rains in 1899 . . . . Price Re. 1*	W. L. Dalla.
Part II, comprising— A discussion of the results of the hourly observations recorded at 29 stations in India given in Volumes V, IX and X of the Indian Meteorological Memoirs . . Price Rs. 3	Sir John Eliot.
Part III, comprising— Discussion of the results of the hourly observations recorded at 29 stations in India given in Volumes V, IX and X of the Indian Meteorological Memoirs (Final chapter and plates). Price Rs. 3	Ditto.
Part IV, comprising— [illegible] 1893— [illegible] Rs. 3*	W. L. Dallas.
[illegible] mperature, 8 A.M. air pressure reduced to 32° F. and rainfall and five day means of normal cloud amount, relative humidity and aqueous vapour pressure at 8 A.M. . . Price Rs. 5*	Sir John Eliot.
Indian Meteorological Memoirs, Vol. XIV, containing :— Monthly and annual rainfall of 457 stations in India to the end of 1900 . . . . . . Price Rs. 3*	Ditto.
Indian Meteorological Memoirs, Vol. XV, containing :— Part I, comprising— Summary and brief discussion of observations of the clouds recorded at six stations in India during the period 1895—1900 . . . . Price Re. 1*	Ditto.
Part II, comprising— Report on cloud observations and measurements at Simla during the period June, 1900, to January, 1902. Price Re. 1*	W. L. Dallas.
Part III, comprising— Discussion of monthly mean surface and underground temperatures, deduced from observations taken at Lahore, Jaipur, Dehra Dun, Allahabad and Calcutta during the years 1880—1901 . . . . . . Price Re. 1*	R. Ll. Jones.
Indian Meteorological Memoirs, Vol. XVI, containing :— Part I, comprising— Monthly means of air-pressure reduced to 32° F. and constant gravity, Lat. 45° . . . . Price Rs. 3	Sir John Eliot.
Part II, comprising— [illegible] of the more important features of [illegible] Asia, the Indian Ocean and neighbouring countries during the period 1892—1902, with Appendices . . . . Price Rs. 3	Ditto.
Indian Meteorological Memoirs, Vol. XVII, containing :— Normal monthly and annual means of temperature, pressure, wind, humidity, cloud, rainfall and number of rainy days of stations in India, etc. . . . . . . Price Rs. 3	Ditto.
Memoirs of the Indian Meteorological Department, Vol. XVIII†	Ditto.
Part I, comprising— A[illegible]ons recorded at [illegible] and at Chitta- [illegible] . Price Rs. 2	Ditto.
Part II‡, comprising— A[illegible] observations recorded at [illegible] February, 1904, and at [illegible], to February, 1904. Price Rs. 2	Ditto.
Part III, comprising— A discussion of the anemographic observations recorded at Allahabad from September, 1890, to August, 1904, and at Lucknow from July, 1878, to October, 1892 . Price Rs. 2	Ditto.
Memoirs of the Indian Meteorological Department, Vol. XIX†	Ditto.
Memoirs of the Indian Meteorological Department, Vol. XX, containing :— Part I, comprising— An account of the preparations made for determining the conditions of the upper air in India by means of kites. Price Re. 1	J. H. Field.
Part II, comprising— Kite flights made at Belgaum during the pre-monsoon and monsoon periods in 1906 . . . . . Price Re. 1	Ditto.
Part III, ‡ .	
Part IV, comprising— A discussion of types of Weather in Madras . Price Re. 1	R. Ll. Jones.
Part V, comprising— A discussion of some of the anemographic observations recorded at Madras . . . . Price Re. 1	Ditto.
Part VI, ‡	Gilbert T. W[illegible]
Part VII, comprising— Kite flights in India and over the neighbouring sea areas during 1907	J. H. Field.

* Copies of publications to the price of which an asterisk is appended are out of print.

† These volumes are in preparation. ‡ This part is in press for publication.